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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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REPLY TO: 3430 Biological Evaluation August 14, 1980

SUBJECT: Barton Flats and San Gorgonio Campground Evaluation

TO: Forest Supervisor, San Bernardino NF

At the request of Robert Tyrrel, Forest Supervisor, San Bernardino N.F., the Barton Flats and San Gorgonio Campgrounds and adjacent roadside areas were examined on July 21-24, 1980 by FIDM entomologist Dave Schultz and pathologist John Kliejunas. They were accompanied by Chuck Richmond from the PSW Experiment Staion.

Observations made in the campgrounds during a recent FIDM training session indicated annosus root disease, dwarf mistletoe, and overstocking as major problems, with Elytroderma disease, oxidant air pollution, and bark beetles also adversely affecting the campgrounds. The objectives of this examination were to evaluate insect and disease problems and formulate management alternatives to assist the Forest in writing a silvicultural prescription for vegetative management of the areas.

The areas were traversed systematically and above ground evidence of insect and/or disease problems were recorded and mapped. Most stumps, present from previous sanitation-salvage logging, were examined for evidence of annosus root disease caused by Fomes annosus, and Armillaria root disease caused by Armillaria mellea.

OBSERVATIONS

The areas examined were in stands composed predominantly of Jeffrey pine, with occasional black oak and some white fir present. Stand density and size class varied from over-stocked pole-size aggregations to open-grown sawtimber. Incense cedar, giant sequoia, juniper and cottonwood have been planted in some open areas where Jeffrey pine and white fir had been cut. Discussion of the problems noted follows.

BARTON FLATS CAMPGROUND

Annosus Root Disease. A total of 123 stumps (121 Jeffrey pine, 2 white fir) had conks of Fomes annosus within the stump or on the outside. Eight annosus centers were delineated on the map (attachment 1). Except for one area bounded by sites 25-29,

30-36, and 47, F. annosus was generally present throughout the campground. Due to the large number of stumps in the campground, samples for culturing were not collected, and it is possible that areas not delineated as infection centers may also be infected by the fungus. Two of the eight areas were discrete annosus centers, with an opening in the center and dying trees on the margins: 1) south of site 46, where two dead Jeffrey pine saplings with small (popcorn) conks were next to an infected stump, and 2) between site 29 and highway 38, where dead pole size pines were present along the margin.

Other delineated annosus centers had living Jeffrey pine and white fir scattered throughout and did not have dead or dying trees along the margins to indicate a discrete center. Some of the Jeffrey pines within these areas were of low vigor as indicated by thin, off-color crowns, and may already be infected by the fungus. Planted tree species within these centers appeared normal, but the roots were not examined for infection by F. annosus and their root systems may not as yet have contacted infected dead roots in the soil. In most instances, campground areas where shade is desired were within annosus centers and the openings were the result of F. annosus infection and subsequent logging.

The areas without apparent F. annosus infection were generally dense, pole-size stands of Jeffrey pine with basal areas ranging from 180 to 360 sq. ft./ac.

Dwarf Mistletoe. Jeffrey pine on the west end of the campground (sites 43-46 and north of the road from site 43) had medium to severe infection of western dwarf mistletoe, Arceuthobium campylopodum. Dwarf mistletoe in the vicinity of site 46 was especially severe, with mistletoe plants on overstory pines serving as a source of infection for the understory pine. Other areas with lighter dwarf mistletoe infection included: 1) a few pines at the entrance with large brooms, 2) a large leaning pine between sites 26 and 27 with numerous brooms which could be pruned, and 3) the area east of sites 38 and 39, with numerous dwarf mistletoe plants on the pole-size pines but little brooming.

Other Problems. Armillaria mellea was found just north of site 10 on one black oak stump and on one nearby pine stump, and on a large mature white fir across the road from site 45. Both locations were within annosus centers. Elytroderma disease, caused by Elytroderma deformans, was noted on Jeffrey pine at three locations. Light infection was present on trees near the entrance. One large pine behind site 30 was broomed. The area south of site 38 to the toilet building had numerous pines with heavy brooming. True mistletoe (Phoradendron bolleanum ssp. pauciflorum) was noted on one mature white fir at the entrance

area. Slight to moderate oxidant air pollution injury, characterized by chlorotic mottle on the foliage of affected pines, was present throughout the campground.

The only insect activity noted in the Barton Flats campground were twig beetles and the Jeffrey pine beetle, Dendroctonus jeffreyi. Twig beetles, Pityogenes spp., were killing twigs in several Jeffrey pines between sites 9 and 12 which probably indicates that their roots were infected with Fomes annosus. The Jeffrey pine beetle was noted at only one location. Two overstory pine just south of site 17 had been hit by lighting. One of these trees had been cut recently and the second had numerous successful beetle attacks. Three pines in the vicinity of these two also were attacked. One had numerous successful attacks and will not likely survive, and the other two had numerous pitch tubes which appeared to be unsuccessful attacks.

At a number of spots in and around the campground, black oak trees were being overtopped by, or were in severe competition with, thickets of Jeffrey pine. The competition will lead to slow growth and slow wound healing of the oaks.

SAN GORGONIO CAMPGROUND

Annosus Root Disease. Conks of F. annosus were found on 57 stumps, all of which were Jeffrey pine. Thirteen annosus centers were delineated on the campground map (attachment 2). The centers at San Gorgonio were more discrete than at Barton Flats except for the five centers east of the entrance road and between the campground road and highway 38. These five centers may have coalesced and the entire area may in fact be infected. The centers north of sites 7, 40, 49, and 51 are fairly discrete, with dense, heavily-mistletoed, pole-sized stands of Jeffrey pine separating them. The root disease apparently hasn't spread south into the main campground from these centers.

Dwarf Mistletoe. Severe infestations of dwarf mistletoe on Jeffrey pine were concentrated in four areas of the campground. Three areas (north of sites 15 and 17, between sites 41 and 43, within and north of sites 46, 47, 48, and 49) contained overstory pines with large brooms and heavily-infected pines in the understory. Pole-size pines in the vicinity of site 30 had severe infection, resulting in distortion of the trees. Infected overstory pines at sites 13, 21, 29, and 45 had large brooms in the lower crowns which could be pruned to increase tree vigor.

Other Problems. Armillaria mellea was found in Jeffrey pine at three locations: 1) a stump at the spur entrance to site 35, 2) a stump at site 17, and 3) in a pine broken off 3 feet above the ground between sites 21 and 22. Elytroderma deformans was noted at only one location, on an overstory Jeffrey pine behind site 6

with medium infection. The Jeffrey pine beetle had killed a standing pine infected with F. annosus at site 23, and was attacking a live overstory pine just north of site 56 which was heavily infected with dwarf mistletoe. Oxidant air pollution injury was slight to moderate. Oaks were under competition from the pine in several spots in and around the campground.

SCENIC STRIP

In general, the south side of the highway was more disease free than the north side and also contained denser stands, with basal areas as high as 460 sq. ft./ac. Four annosus centers were delineated on the map (attachment 3). The first two centers from west to east, had dead or dying Jeffrey pine at margins of the centers. Light infections of dwarf mistletoe and E. deformans were noted near the western margins of the first annosus center. No insect problems were noted along the strip.

BIOLOGY OF PEST ORGANISMS

ANNOSUS ROOT DISEASE

Fomes annosus is a root rotting fungus that attacks a wide range of woody plants, causing a decay of wood and death of sapwood and cambium. All conifer species in California are susceptible to the fungus. Hardwood species are rarely damaged or killed; but madrone, Arbutus menziesii, and a few brush species including manzanita, Arctostaphylos spp., and sagebrush, Artemisia tridentata, are attacked.

During favorable periods, the fungus forms fruiting bodies in decayed stumps, under the bark of dead trees, or in the duff at the root collar. The fungus becomes established in freshly cut stumps from air-borne spores produced by the conks, and then grows into the root system. The fungus subsequently spreads to healthy roots of surrounding susceptible tree species via root contacts. Local spread of the fungus outward from a stump typically results in the formation of disease centers with dead trees in the center and fading trees on the margin. These centers usually continue to enlarge until they reach barriers such as openings or groups of non-susceptible plants.

The fungus may remain alive for as long as 50 years as a saprophyte in infected roots and stumps. Young susceptible tree species often become infected and die after their roots contact old infected root systems in the soil.

DWARF MISTLETOE

The dwarf mistletoes are parasitic seed plants that attack only conifers. Western dwarf mistletoe infects Jeffrey, ponderosa, knobcone, and Coulter pines. The dwarf mistletoes are obligate parasites which are completely dependent on their host for support, for water, and for most of their mineral and organic nutrients. They often cause the formation of "witches brooms", or dense masses of distorted branches, on the host which divert nutrients from the rest of the tree.

Dwarf mistletoes spread between trees and within crowns of trees by means of small seeds that are forcibly ejected into the air. Spread from overstory to understory is limited to the distance traveled by the seeds, usually 20-60 feet, but as much as 100 feet if assisted by wind. Dwarf mistletoe spreads upward in infected trees at a rate of about 4 inches/year.

ARMILLARIA ROOT ROT

Armillaria mellea is a fungus which causes a root and root collar decay of more than 600 species of conifers, hardwoods, shrubs and herbaceous plants. After the fungus has developed in an infected tree, using the dead stump or root as a food base, it produces structures called rhizomorphs, or strands of fungal tissue. Rhizomorphs formed on decayed wood of diseased trees grow through the soil like roots and may infect surrounding living trees, especially young conifers. When the rhizomorph comes in contact with a nearby susceptible root, it adheres and penetrates through the bark to the cambium region. The fungus grows in the cambial area and produces a white, flat, leathery, fan-shaped mycelial mat. A network of rhizomorphs is often associated with the mat. From the mats the fungus penetrates xylem tissue and produces a white to yellowish stringy rot that is often accompanied by fine black zone lines.

Armillaria mellea is present in most forests and is usually prevalent where oak is a stand component. Since the fungus exists in most soils, successful infection is usually related to low tree vigor. Death or decreased vigor of oaks allows the fungus to penetrate, decay tissues, and form rhizomorphs. Oak stumps provide a food base for the fungus which is essential for the production and growth of rhizomorphs through the soil. Therefore, the presence or creation of dead oak roots/stumps increases the probability of infection of surrounding conifers by rhizomorphs of the fungus. Stumps and roots infected with A. mellea act as disease centers as long as they provide a suitable food base for the rhizomorphs. Mortality of young conifers will probably not begin until four to five years after oaks are killed, but, once it begins, mortality may continue for five

years or more. If overmature oaks, which are hazard trees, are to be removed from the campgrounds, treating them so that they decline gradually rather than rapidly will reduce the amount of food base available at any one time. Removal of stumps will also decrease the food base available.

ELYTRODERMA DISEASE

Elytroderma disease is caused by Elytroderma deformans, a fungus which infects mainly Jeffrey and ponderosa pines. It has also been reported on knobcone, lodgepole, and pinyon pines. The disease is spread by spores which are dispersed from small fruiting bodies produced on infected needles. After the spores infect current year's needles, the fungus becomes systemic in twigs. This perennial twig infection serves to reinfect each year's needles as they grow out and causes them to die and drop off the second year. Infected twigs retain only the current year's needles. The systemic infections also produce "witches brooms" similar in appearance to witches brooms produced by dwarf mistletoes.

The disease may cause significant growth loss when more than 40% of the crown is infected. The impact of the disease can be reduced by removing trees with more than 40% of the crown infected and by favoring resistant species. Although direct killing of mature trees is infrequent, moderate to severe infection predisposes the tree to other diseases and to bark beetle attack. In areas such as the Barton Flats campground where infection is generally light, pruning of brooms may restore the vigor of weakened trees.

JEFFREY PINE BEETLE

The Jeffrey pine beetle, Dendroctonus jeffreyi, attacks only Jeffrey pine. There is one generation per year with adults attacking trees from late March through October. Only the bole of the tree is attacked, and it will not breed in the branches or slash. The Jeffrey pine beetle normally attacks scattered individual trees which are predisposed by overmaturity, lightning strike, root disease or extremely heavy infections of dwarf mistletoe or Elytroderma disease. This beetle has an aggregating pheromone which serves to attract other Jeffrey pine beetles into the area of a tree under attack. Once the beetles are near the initial tree under attack, they may be able to overcome other, healthy trees by their sheer numbers. In years of adequate precipitation, mortality due to the Jeffrey pine beetle usually occurs as single trees or several trees growing close to each other. When precipitation is below normal, the Jeffrey pine beetle can kill larger groups of trees, including some apparently healthy trees.

Jeffrey pine in the campgrounds which are currently in, or on the edge of, annosus centers will probably become infected with root disease and will be attacked by the Jeffrey pine beetle. Pine mortality outside infection centers can be kept at a low level by measures designed to maintain or increase the vigor of the trees. Pruning large dwarf mistletoe brooms from overstory trees and thinning younger stands that are infected will increase tree vigor and make them more resistant to bark beetles. Reducing the total basal area to 150 sq. ft./ac., or less where grass or brush is present, will probably result in less bark beetle-caused mortality during future periods of reduced precipitation. Rapid destruction or disposal of fresh pine slash will prevent the buildup of pine engravers, Ips spp., that would otherwise cause top killing and predispose trees to the Jeffrey pine beetle. Vehicular traffic, construction and paving can be routed away from trees and their root zones to avoid wounding and root compaction that will predispose the trees to bark beetle attack.

PINE ENGRAVER BEETLE

Although pine engraver beetles, Ips spp., were not noted in this evaluation of the campgrounds, in May they were observed in the area breeding in pine slash caused by storms earlier in the year. Pine engravers will breed either in the tops of live pine trees or in fresh green slash. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire, or the attack of other insects. If fresh slash is available in the spring, the pine engravers may build up in an area and cause locally heavy top killing by mid-summer. Attacks are made with the coming of warm weather in the spring. A new generation is produced in 6-8 weeks in the spring, to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon species involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as severe competition or sudden opening of the stand. Tree killing frequently occurs where green pine slash, which serves as breeding habitat, is left untreated during spring and summer.

Fresh pine slash caused by thinning, dwarf mistletoe control work, construction or winter storm breakage can be modified in a number of ways to make it unsuitable for pine engraver breeding. One approach to minimizing damage is to schedule slash-generation activities mostly in the late summer, fall and early winter, when the beetles are not flying or the slash has a high probability of drying out before the beetles can complete their development. Green pine slash created during the spring and summer should be

treated to prevent the buildup of pine engraver populations. Because pine engravers can complete their development in about a month under ideal conditions, treatment should be carried out soon after cutting to be effective. Some methods of slash treatment that might be acceptable in dispersed recreation areas would include lopping and scattering slash in sunny areas to speed its drying out, crushing or mashing slash with logging equipment to make it unsuitable for pine engraver breeding, or piling and burning the slash within a month of cutting. Broadcast burning the slash might work if it could be done while the slash was green without damaging the residual stand. Another method which might work is to pile slash in a sunny area and tightly cover the pile with clear plastic. If the temperature under the bark of slash in all parts of the pile reaches 120°F, all brood currently in the pile will be killed. Lower temperatures will not be effective and where successful, this method will not prevent reinfestation of slash piles. The most acceptable methods of slash treatment in high-use recreation areas would probably be disposal by chipping or removal from the site.

MANAGEMENT OPTIONS

1. No change in present management. Fomes annosus will persist in the infected stumps and roots until the wood has been completely rotted. Trees on the edge of active annosus centers will become infected and will probably die after being attacked by bark beetles. Conifers planted in the infection centers will become infected and die as their roots reach old infected roots and stumps and the fungus will be perpetuated in the area. Dense thickets of young pines will probably be attacked by bark beetles or engraver beetles when precipitation drops below normal. Conifers will compete with some of the existing oak trees, resulting in a reduction of oak vigor and growth. That will slow wound healing, promoting heart rot and increasing the rate of branch and tree failures: tree hazards.

2. Move the campgrounds. The campgrounds could be moved to the south side of the road where there is little dwarf mistletoe, a few fairly discrete annosus centers, and where the major problem is overstocking. If roads and major improvements were put in the existing centers and the other areas were thinned, with appropriate treatments for the stumps and slash, the new campgrounds would probably be little affected by insect and/or disease problems for several decades.

3. Reduce impact of Fomes annosus. Once annosus root disease is established in a stand, no direct procedure

is available for controlling it. Control, therefore, involves prevention of new centers by decreasing the risk of stump infection, and silvicultural manipulation of infected stands to minimize the effects of the disease. The following alternatives are available:

a. Prevent stump infection. Application of granular borax to freshly cut stumps is effective in preventing most (90%) new infections. The chemical is toxic to the spores of F. annosus, but has no effect on existing infections. Borax application is required on all stumps cut in and near developed recreation sites (FSM R-5 Supp. 2305 and 2331.33). Application requires the submission of a Pesticide Use Request.

b. Plant hardwoods. Revegetation of active annosus centers should be done only with resistant species. All conifers are susceptible to the fungus. Leaving the centers barren or planting them with resistant hardwoods will result in the fungus eventually dying out so that conifers can again be regenerated. Unfortunately, this will likely take 50 or more years.

   Favoring the hardwoods already present and planting other suitable hardwoods will provide shade as well as establish a barrier of non-susceptible roots which may limit the spread of the infection centers. There will probably be fewer problems in maintaining the plantings if the trees or shrubs are transplanted or grown from seed collected near the campgrounds. Trees observed in the general vicinity of the campgrounds included black oak, interior live oak and white alder. Some locally occurring shrubs were elderberry, whitethorn, willow and mountain mahogany. Although numerous other hardwood species occur naturally within 20 miles of the campgrounds, most are riparian species, and, with the possible exceptions of California box-elder, Pacific dogwood, California laurel, velvet ash and Populus spp., they may not be suitable for planting in the campgrounds.

c. Stump and root removal. Stumps which were apparently created by the 1953-54 sanitation-salvage operation in the Barton Flats campground are still present and many are infected with F. annosus. Removal of as much infected material as possible will disrupt the underground network for fungal spread and establish a barrier to further spread. After the fine roots that remain in the soil have

completely decomposed, the site will be suitable for conifer regeneration. Recently cut stumps can probably be removed by pulling or by explosives. Partially decomposed stumps could be removed only by excavation with a backhoe or by hand.

d. Thinning and interplanting. Thinning of dense pole-size stands of susceptible conifer species and interplanting with resistant hardwood species will minimize opportunities for root contact and subsequent spread. Sparse stands or stands of mixed susceptible and resistant trees will be less subject to damage. Thinning will also increase tree vigor and thus reduce the risk of damaging activity by bark beetles. Stumps created during thinning must be treated with borax and slash should be treated to minimize pine engraver buildups.

e. Fumigation. Fumigation of F. annosus - infected stumps with methyl bromide to kill the fungus, has been successful experimentally in the Northeast. Fumigation, along with physical removal of infected material, has not been successful in stopping spread of an annosus center at the Institute of Forest Genetics arboretum at Placerville. The technique has not been tried under southern California conditions.

4. Thin around existing oaks. Some of the oak trees in both campgrounds are under competition from the surrounding pines. The competition and shading have resulted in some oaks having dead branches, slow growth and slow wound healing. Thinning pines around oak trees would extend the useful life span of the oaks and may reduce the likelihood of tree failure. Conifer stumps should be treated with borax and the slash should be treated to minimize pine engraver buildups.

5. Reduce impact of dwarf mistletoe. Several alternatives for reducing the impact of dwarf mistletoe in recreational sites are available. FIDM funding may be available for approved dwarf mistletoe control projects. It should be kept in mind that even if efforts to control dwarf mistletoe are successful, the trees will likely die from root rot and subsequent beetle attack if they are within active annosus centers.

a. Broom pruning. Both campgrounds have trees which would benefit from broom pruning. High-value trees can be pruned of large brooms in the lower crown if, after removal of the brooms, the trees will have

live crown ratios of 30% or more. Removal of brooms would increase the vigor of the trees and extend their life.

b. Thinning of even aged stands. Thinning of infected stands will maintain optimum growth of the residuals and reduce stress. Mistletoe-infected trees should be selected against. The removal of all trees with Hawksworth dwarf mistletoe rating of 5 and 6 should be considered because these trees will likely die within the next 10-year period, most likely during the next drought. Treat all freshly cut stumps with borax to prevent invasion by F. annosus.

c. Remove infected overstory trees. Removal of infected overstory trees will eliminate a source of infection for surrounding understory trees. The remaining understory can then be thinned and/or pruned to eliminate dwarf mistletoe infections.

6. Control squirrels and other rodents. The area around and between the campgrounds seems to support large numbers of ... squirrels and other rodents, and there is a general lack of oak reproduction. Whether or not the seed-eating animals are partially responsible we don't know. Generally squirrels bury more acorns than they find later for food, thus aiding oak regeneration. It may be advisable to have a wildlife biologist provide site-specific advice on this question and one other: whether reduction of the rodent population ought to be encouraged in order to reduce chances of an outbreak of sylvatic plague, with its attendant risk to visitors.

7. Integrate treatments. Management alternatives 3 through 6 are not mutually exclusive. They can be used alone or in combination in various parts of the campgrounds and roadside view area to produce the desired results. Consideration of the interactions among all insect and disease problems present will result in a successful integration of pest management strategies.

For clarification or additional information contact Dave Schultz or John Kliejunas of the FIDM Staff.

Wilfred L. Freeman Jr.

WILFRED L. FREEMAN, JR., Director
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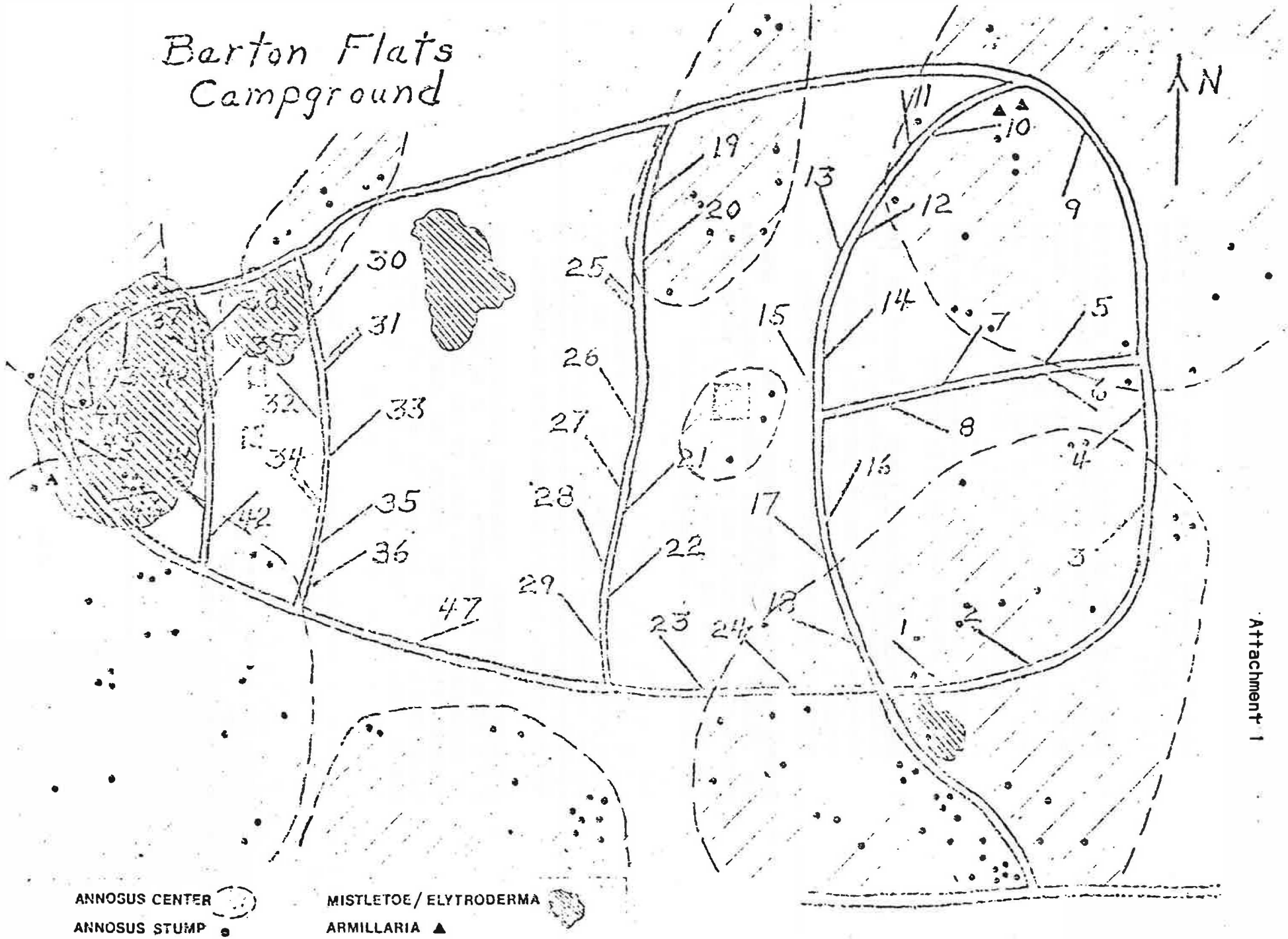
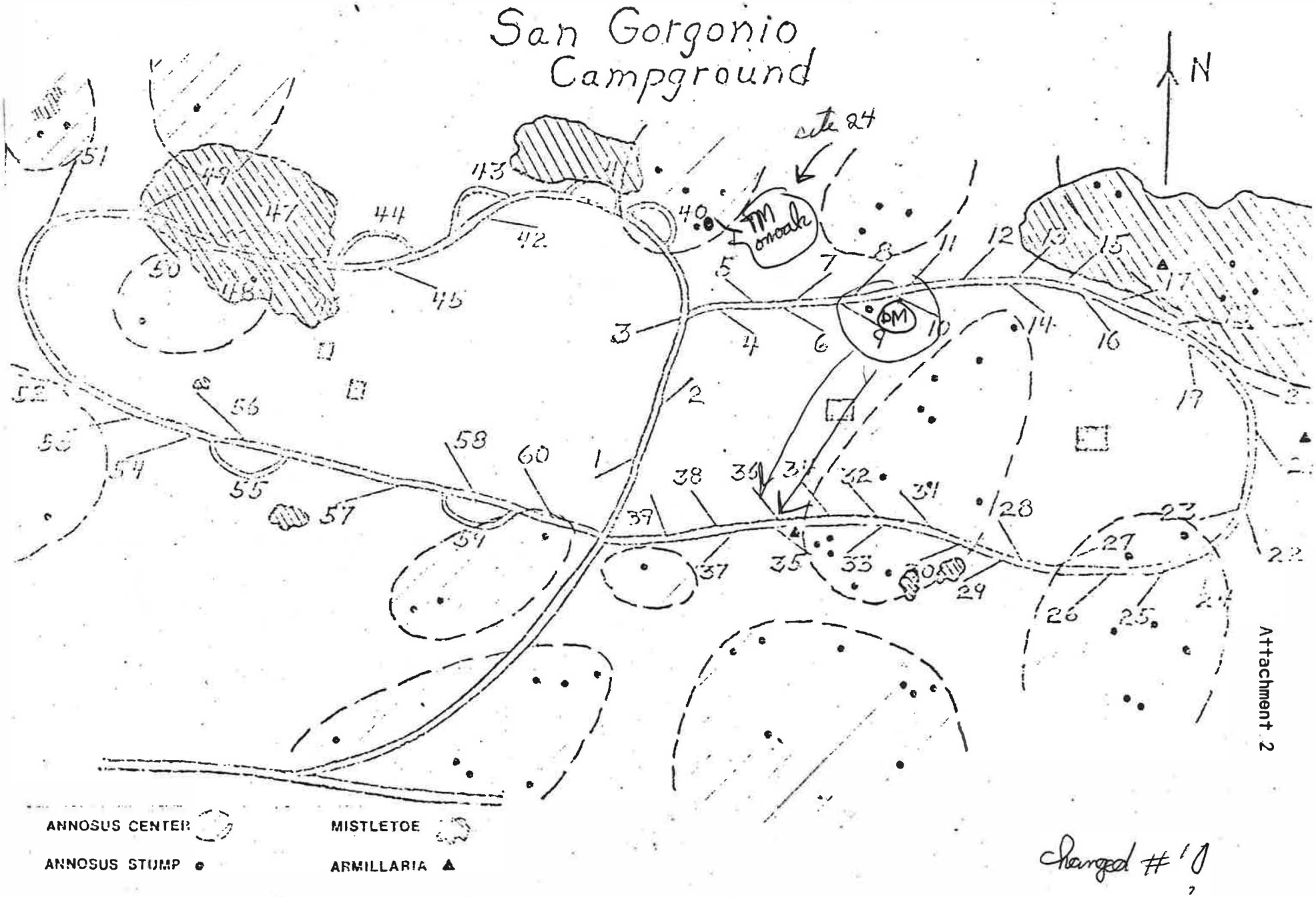
Enclosures

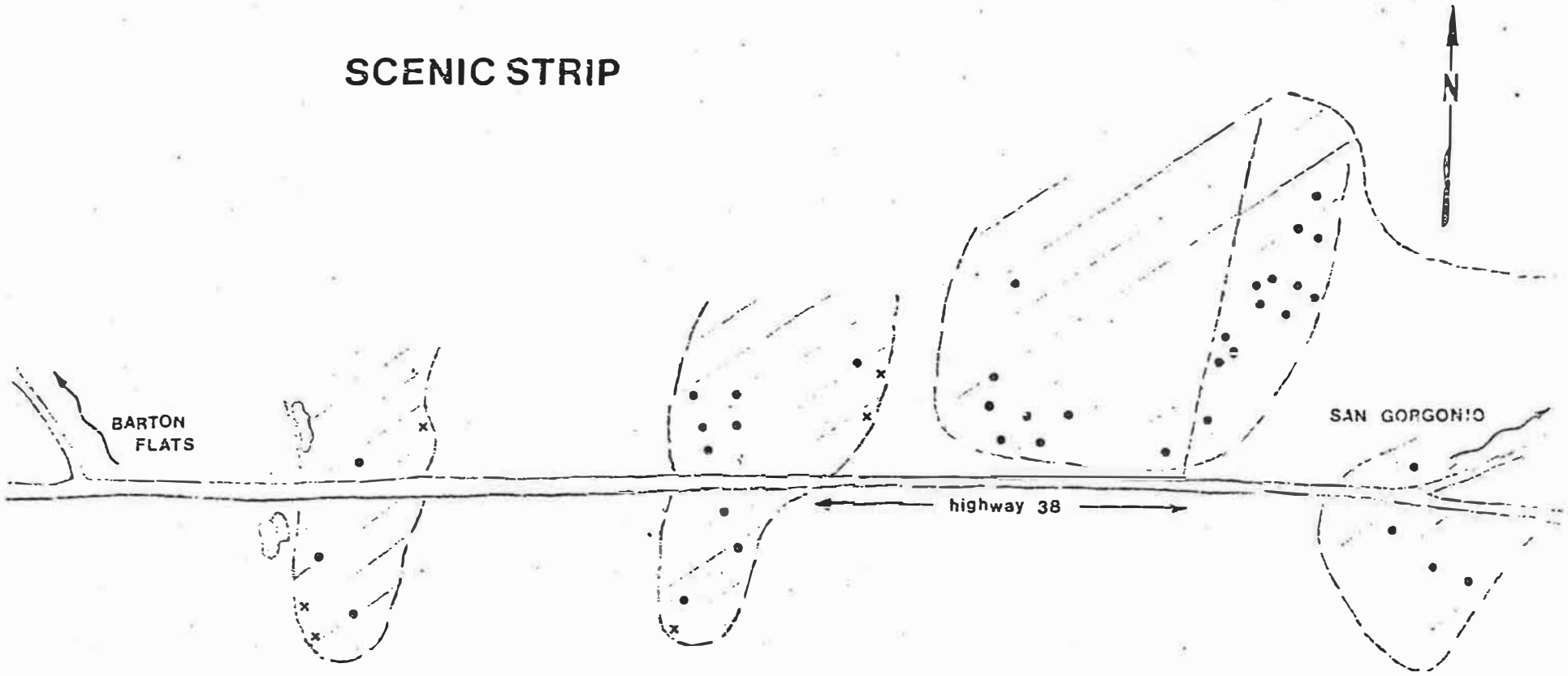


Attachment 1



Attachment 2

SCENIC STRIP



ANNOSUS CENTER

ANNOSUS STUMP •

TRAIL ----

MISTLETOE/ELYTRODERMA

DEAD/DYING PINE ×

Attachment 3